Apprenticeship and Industry Training

Machinist

Apprenticeship Course Outline

1514.3 (2014)

Alberta

Apprenticeship and Industry Training

ALBERTA INNOVATION AND ADVANCED EDUCATION

***Machinist : apprenticeship course outline*:**

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Course Outline

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Apprenticeship

Apprenticeship is post-secondary education with a difference. Apprenticeship begins with finding an employer. Employers hire apprentices, pay their wages and provide on-the-job training and work experience. Approximately 80 per cent of an apprentice's time is spent on the job under the supervision of a certified journeyperson or qualified tradesperson. The other 20 per cent involves technical training provided at, or through, a post-secondary institution – usually a college or technical institute.

To become certified journeypersons, apprentices must learn theory and skills, and they must pass examinations. Requirements for certification—including the content and delivery of technical training—are developed and updated by the Alberta Apprenticeship and Industry Training Board on the recommendation of Machinist Provincial Apprenticeship Committee.

The graduate of the Machinist apprenticeship program is a certified journeyperson who will be able to:

- understand the principles of sound and safe trade practice
- interpret drawings, plans, and be able to layout and develop projects according to specifications
- use the tools of the trade in a safe and proper manner
- relate to the work of other tradespeople employed in the industry either on construction or in maintenance
- perform assigned tasks in accordance with quality and production standards required in industry
- perform assigned tasks in accordance with quality and production standards required by industry

Apprenticeship and Industry Training System

Industry-Driven

Alberta's apprenticeship and industry training system is an industry-driven system that ensures a highly skilled, internationally competitive workforce in more than 50 designated trades and occupations. This workforce supports the economic progress of Alberta and its competitive role in the global market. Industry (employers and employees) establishes training and certification standards and provides direction to the system through an industry committee network and the Alberta Apprenticeship and Industry Training Board. The Alberta government provides the legislative framework and administrative support for the apprenticeship and industry training system.

Alberta Apprenticeship and Industry Training Board

The Alberta Apprenticeship and Industry Training Board provide a leadership role in developing Alberta's highly skilled and trained workforce. The board's primary responsibility is to establish the standards and requirements for training and certification in programs under the Apprenticeship and Industry Training Act. The board also provides advice to the Minister of Advanced Education on the needs of Alberta's labour market for skilled and trained workers, and the designation of trades and occupations.

The thirteen-member board consists of a chair, eight members representing trades and four members representing other industries. There are equal numbers of employer and employee representatives.

Industry Committee Network

Alberta's apprenticeship and industry training system relies on a network of industry committees, including local and provincial apprenticeship committees in the designated trades, and occupational committees in the designated occupations. The network also includes other committees such as provisional committees that are established before the designation of a new trade or occupation comes into effect. All trade committees are composed of equal numbers of employer and employee representatives. The industry committee network is the foundation of Alberta's apprenticeship and industry training system.

Local Apprenticeship Committees (LAC)

Wherever there is activity in a trade, the board can set up a local apprenticeship committee. The board appoints equal numbers of employee and employer representatives for terms of up to three years. The committee appoints a member as presiding officer. Local apprenticeship committees:

- monitor apprenticeship programs and the progress of apprentices in their trade, at the local level
- make recommendations to their trade's provincial apprenticeship committee (PAC) about apprenticeship and certification in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- make recommendations to the board about the appointment of members to their trade's PAC
- help settle certain kinds of disagreements between apprentices and their employers
- carry out functions assigned by their trade's PAC or the board

Provincial Apprenticeship Committees (PAC)

The board establishes a provincial apprenticeship committee for each trade. It appoints an equal number of employer and employee representatives, and, on the PAC's recommendation, a presiding officer - each for a maximum of two terms of up to three years. Most PAC's have nine members but can have as many as twenty-one. Provincial apprenticeship committees:

- Make recommendations to the board about:
    - standards and requirements for training and certification in their trade
    - courses and examinations in their trade
    - apprenticeship and certification
    - designation of trades and occupations
    - regulations and orders under the Apprenticeship and Industry Training Act
- monitor the activities of local apprenticeship committees in their trade
- determine whether training of various kinds is equivalent to training provided in an apprenticeship program in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- consult with other committees under the Apprenticeship and Industry Training Act about apprenticeship programs, training and certification and facilitate cooperation between different trades and occupations
- consult with organizations, associations and people who have an interest in their trade and with employers and employees in their trade
- may participate in resolving certain disagreements between employers and employees
- carry out functions assigned by the board

Machinist PAC Members at the time of publication

Mr. B. Wermann	Edmonton	Presiding Officer
Mr. G. Callies	Gwynne	Employer
Mr. M. Desjardins	Calgary	Employer
Mr. D. Short	Edmonton	Employer
Mr. J. Irving	South	Employer
Mr. M. Gamache	Edmonton	Employee
Mr. N. Forbes	Edmonton	Employee
Mr. R. Roes	Peace River	Employee
Mr. K. McGrath	Red Deer	Employee

Alberta Government

Alberta Advanced Education works with industry, employer and employee organizations and technical training providers to:

- facilitate industry's development and maintenance of training and certification standards
- provide registration and counselling services to apprentices and employers
- coordinate technical training in collaboration with training providers
- certify apprentices and others who meet industry standards

Technical Institutes and Colleges

The technical institutes and colleges are key participants in Alberta's apprenticeship and industry training system. They work with the board, industry committees and Alberta Advanced Education to enhance access and responsiveness to industry needs through the delivery of the technical training component of apprenticeship programs. They develop lesson plans from the course outlines established by industry and provide technical training to apprentices.

Apprenticeship Safety

Safe working procedures and conditions, incident/injury prevention, and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, employers, employees, apprentices and the public. Therefore, it is imperative that all parties are aware of circumstances that may lead to injury or harm.

Safe learning experiences and healthy environments can be created by controlling the variables and behaviours that may contribute to or cause an incident or injury. By practicing a safe and healthy attitude, everyone can enjoy the benefit of an incident and injury free environment.

Alberta Apprenticeship and Industry Training Board Safety Policy

The Alberta Apprenticeship and Industry Training Board (board) fully supports safe learning and working environments and emphasizes the importance of safety awareness and education throughout apprenticeship training- in both on-the- job training and technical training. The board also recognizes that safety awareness and education begins on the first day of on-the-job training and thereby is the initial and ongoing responsibility of the employer and the apprentice as required under workplace health and safety training. However the board encourages that safe workplace behaviour is modeled not only during on-the-job training but also during all aspects of technical training, in particular, shop or lab instruction. Therefore the board recognizes that safety awareness and training in apprenticeship technical training reinforces, but does not replace, employer safety training that is required under workplace health and safety legislation.

The board has established a policy with respect to safety awareness and training:

> **The board promotes and supports safe workplaces, which embody a culture of safety for all apprentices, employers and employees. Employer required safety training is the responsibility of the employer and the apprentice, as required under legislation other than the *Apprenticeship and Industry Training Act.***

The board's complete document on its 'Apprenticeship Safety Training Policy' is available at www.tradesecrets.alberta.ca; access the website and conduct a search for 'safety training policy'.

Implementation of the policy includes three common safety learning outcomes and objectives for all trade course outlines. These common learning outcomes ensure that each course outline utilizes common language consistent with workplace health and safety terminology. Under the title of 'Standard Workplace Safety', this first section of each trade course outline enables the delivery of generic safety training; technical training providers will provide trade specific examples related to the content delivery of course outline safety training.

Occupational Health and Safety

A tradesperson is often exposed to more hazards than any other person in the work force and therefore should be familiar with and apply the Occupational Health and Safety Act, Regulations and Code when dealing with personal safety and the special safety rules that apply to all daily tasks.

Occupational Health and Safety (a division of Alberta Human Services) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at www.humanservices.alberta.ca

Technical Training

Apprenticeship technical training is delivered by the technical institutes and many colleges in the public post-secondary system throughout Alberta. The colleges and institutes are committed to delivering the technical training component of Alberta apprenticeship programs in a safe, efficient and effective manner. All training providers place great emphasis on safe technical practices that complement safe workplace practices and help to develop a skilled, safe workforce.

The following institutions deliver Machinist apprenticeship technical training:

Northern Alberta Institute of Technology Southern Alberta Institute of Technology

Procedures for Recommending Revisions to the Course Outline

Advanced Education has prepared this course outline in partnership with the Machinist Provincial Apprenticeship Committee.

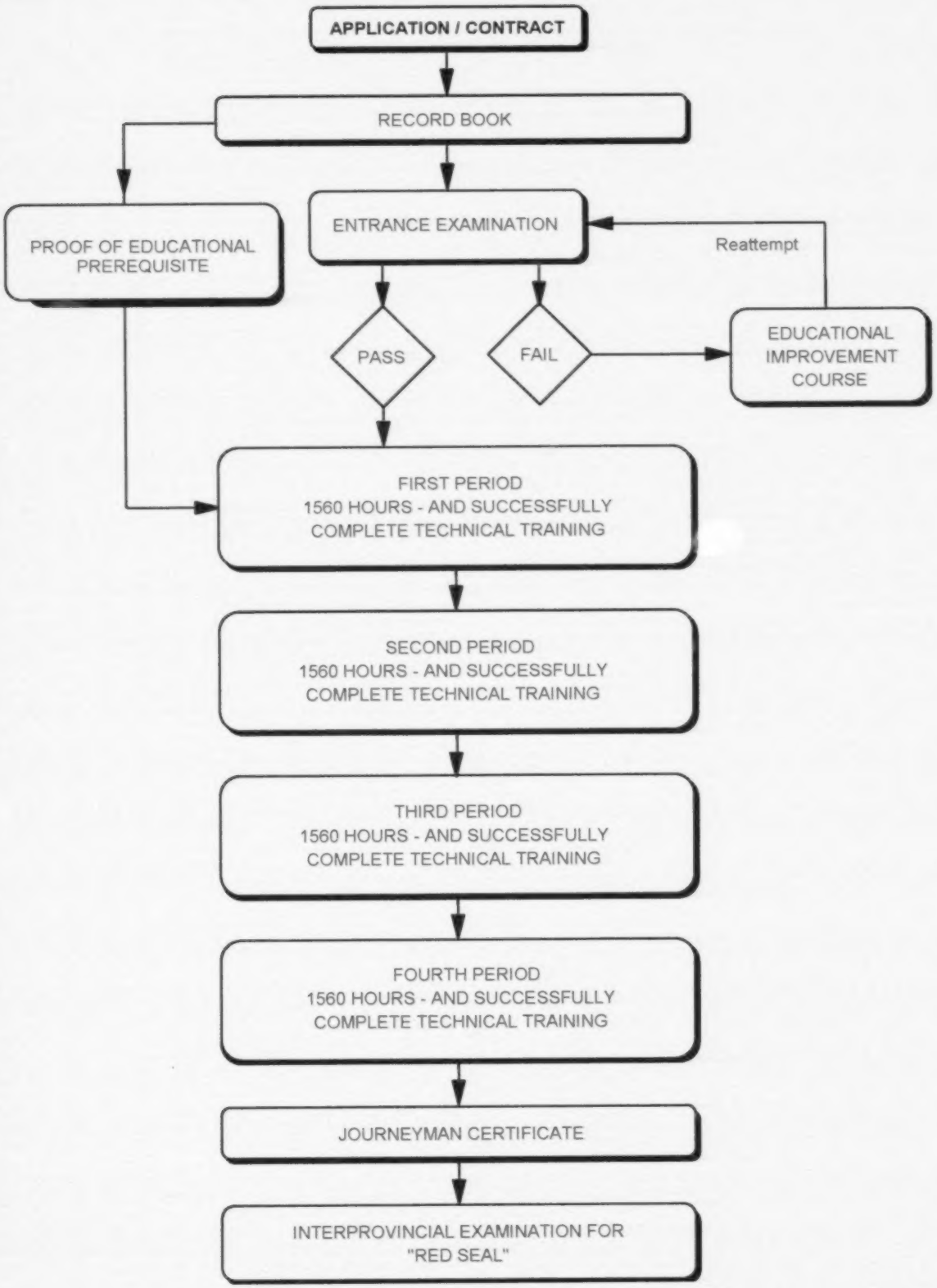
This course outline was approved on December 13, 2013 by the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. The valuable input provided by representatives of industry and the institutions that provide the technical training is acknowledged.

Any concerned individual or group in the province of Alberta may make recommendations for change by writing to:

Machinist Provincial Apprenticeship Committee
c/o Industry Programs and Standards
Apprenticeship and Industry Training
Advanced Education
10th floor, Commerce Place
10155 102 Street NW
Edmonton AB. T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used. Recommendations for change will be placed on the agenda for regular meetings of the Machinist Provincial Apprenticeship Committee.

Apprenticeship Route toward Certification



Machinist Training Profile
FIRST PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

SAFETY AND MEASUREMENT
36 HOURS

A	B	C
Safety Legislation, Regulation & Industry Policy in the Trades 2 Hours	Climbing, Lifting, Rigging and Hoisting 2 Hours	Hazardous Materials & Fire Protection 2 Hours
D	**E**	**F**
Oxy-fuel Equipment Safety 4 Hours	Layout Tools and Procedures 3 Hours	Hand-Held Cutting Tools 6 Hours
G	**H**	**I**
Measurement Tools 4 Hours	Angular Measuring Tools 3 Hours	Screw Thread Terminology 5 Hours
J	**K**	
Screw Thread Measuring and Gauging 3 Hours	Inspection Gauges 2 Hours	

SECTION TWO

MACHINE TOOLS
140 HOURS

A	B	C
Hand Grinding Machines 8 Hours	Power Saws 2 Hours	Speeds, Feeds and Cutting Tools 8 Hours
D	**E**	**F**
Drilling Machines 16 Hours	Lathes 6 Hours	Lathe Attachments and Accessories 10 Hours
G	**H**	**I**
Lathe Operations 58 Hours	Machine Lubrication and Cutting Fluids 2 Hours	Introduction & Application of CNC Turning Machines 2 Hours
J	**K**	**L**
Machine Coordinate Systems for CNC Turning Machines 2 Hours	Parts & Workholding Accessories for CNC Turning Machines 2 Hours	Set-up & Operation for CNC Turning Machines 24 Hours

SECTION THREEE

TRADE MATH
32 HOURS

A	B	C
Working with Numbers 4 Hours	Fractions, Decimals & Percentages 4 Hours	Algebra 6 Hours
D	**E**	**F**
Measurement and Conversions 4 Hours	Ratio and Proportion 3 Hours	Taper Systems 3 Hours
G		
Introduction to Triangles and Trigonometry 8 Hours		

SECTION FOUR

PRINT READING
32 HOURS

A	B	C
Introduction to Print Reading 8 Hours	Dimensioning Methods 2 Hours	Sections 2 Hours

D	E	F
Isometric Drawings 2 Hours	Surface Texture (Finish) - Turning 3 Hours	Introduction to Geometric Dimensioning and Tolerancing 3 Hours
G	**H**	**I**
Introduction to Limits and Fits 2 Hours	Introduction to Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) 8 Hours	Fasteners and Locking Devices 2 Hours

SECOND PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

METALLURGY AND HEAT TREATMENT
18 HOURS

A	B	C
Ferrous Metals 6 Hours	Non-Ferrous Metals 6 Hours	Metal Specifications and Testing 6 Hours

SECTION TW0

TOOLING
16 HOURS

A	B	C
Tool and Workholding Devices 2 Hours	Milling Cutters 4 Hours	Cutting Tool Materials 4 Hours

D
Inserts and Tool Holders 6 Hours

SECTION THREE

MACHINE TOOLS
154 HOURS

A	B	C
Milling Machines 4 Hours	Milling Operations 58 Hours	Dividing Head and Indexing 6 Hours
D	**E**	**F**
Threading 20 Hours	Program and Machine Coordinate Systems for CNC Machining Centers 2 Hours	Parts for CNC Machining Centers 4 Hours
G	**H**	**I**
Programming Concepts and Codes for CNC Machining Centers 6 Hours	Set-up and Operation for CNC Machining Centers 50 Hours	Process Planning 4 Hours

SECTION FOUR

TRADE MATH
24 HOURS

A	B
Applied Mathematics 14 Hours	Applied Geometry 10 Hours

SECTION FIVE

PRINT READING
28 HOURS

A	B	C
Interpret and Sketch Prints 8 Hours	Advanced Geometric Dimensioning and Tolerancing 4 Hours	Surface Texture (Finish) - Milling 2 Hours
D	**E**	**F**
Application of Limits and Fits 4 Hours	Computer Aided Design (CAD)and Computer Aided Manufacturing (CAM) 8 Hours	Assembly and Sub-Assembly Drawings 2 Hours

THIRD PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

COMPUTER NUMERICAL CONTROL MACHINES (CNC)
94 HOURS

A	B	C
Codes and Formats 6 Hours	Linear and Circular Interpolation 4 Hours	Canned Cycles 4 Hours
D	**E**	**F**
Multiple Repetitive Cycles 8 Hours	Tool Nose Radius Compensation 3 Hours	CNC Threading 5 Hours
G	**H**	**I**
Programming CNC Threads 6 Hours	Tool Measurements 4 Hours	Machine Operations 48 Hours
J		
Multi Axis Turning 6 Hours		

SECTION TWO

MACHINE TOOLS
90 HOURS

A	B	C
Gearing 5 Hours	Spur Gears 6 Hours	Bevel Gears 4 Hours
D	**E**	**F**
Helical Gears 4 Hours	Gear Manufacturing Methods 12 Hours	Multi Start and Worm Threading 12 Hours
G	**H**	**I**
Abrasives 6 Hours	Grinding Machines 24 Hours	Machine Broaching 2 Hours
J	**K**	
Splines 10 Hours	Fixtures 5 Hours	

SECTION THREE

TRADE MATH
24 HOURS

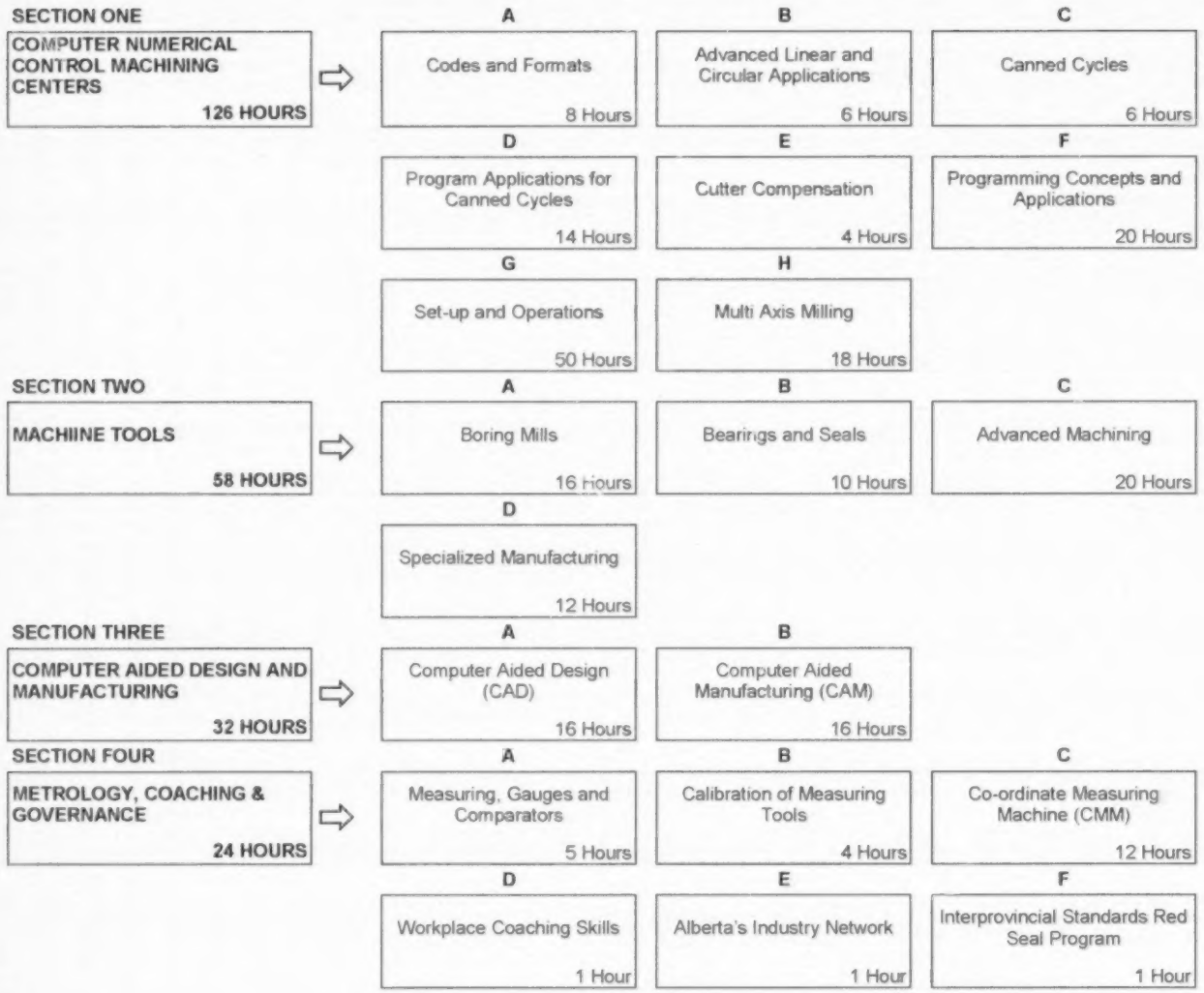
A	B	C
Applied Mathematics 2 Hours	Trigonometry Applications 10 Hours	Advanced Limits and Fits 12 Hours

SECTION FOUR

COMPUTER AIDED DESIGN AND MANUFACTURING
32 HOURS

A	B	C
Computer Aided Design (CAD) 14 Hours	Computer Aided Manufacturing (CAM) 14 Hours	Co-ordinate Measuring Machining (CMM) 2 Hours
D		
Advanced Process Planning - Estimating 2 Hours		

FOURTH PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)



NOTE: The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training.

FIRST PERIOD TECHNICAL TRAINING
MACHINIST TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE WILL BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

It is industry's intent that the practical portion of the program enhances the theory section of the course outline. Geometric Dimensioning and Tolerancing to be incorporated practically into all working drawings and that the Machinery Handbook be used in all periods of training. Due to the nature of the work of the Machinist trade it is imperative that safety, WHMIS and environmental concerns be taught on a continuous basis throughout the entirety of this course.

SECTION ONE: .....SAFETY AND MEASUREMENT..... 36 HOURS

A. Safety Legislation, Regulation & Industry Policy in the Trades.....2 Hours

Outcome: ***Describe legislation, regulations and practices intended to ensure a safe work place in this trade.***

1. Demonstrate the ability to apply the Occupational Health and Safety Act, Regulation and Code.
2. Explain the role of the employer and employee in regard to Occupational Health and Safety (OH&S) regulations, Worksite Hazardous Materials Information Systems (WHMIS), fire regulations, Workers Compensation Board regulations, and related advisory bodies and agencies.
3. Explain industry practices for hazard assessment and control procedures.
4. Describe the responsibilities of workers and employers to apply emergency procedures.
5. Describe positive tradesperson attitudes with respect to housekeeping, personal protective equipment and emergency procedures.
6. Describe the roles and responsibilities of employers and employees with respect to the selection and use of personal protective equipment (PPE).
7. Select, use and maintain appropriate PPE for worksite applications.

B. Climbing, Lifting, Rigging and Hoisting .....2 Hours

Outcome: ***Describe the use of personal protective equipment (PPE) and safe practices for climbing, lifting, rigging and hoisting in this trade.***

1. Select, use and maintain specialized PPE for climbing, lifting and load moving equipment.
2. Describe manual lifting procedures using correct body mechanics.
3. Describe rigging hardware and the safety factor associated with each item.
4. Select the correct equipment for rigging typical loads.
5. Describe hoisting and load moving procedures.

C. Hazardous Materials & Fire Protection .....2 Hours

Outcome: ***Describe the safety practices for hazardous materials and fire protection in this trade.***

1. Describe the roles, responsibilities features and practices related to the workplace hazardous materials information system (WHMIS) program.
2. Describe the three key elements of WHMIS.

3. Describe handling, storing and transporting procedures when dealing with hazardous material.
4. Describe safe venting procedures when working with hazardous materials.
5. Describe fire hazards, classes, procedures and equipment related to fire protection.

D. Oxy-Fuel Equipment Safety ..... 4 Hours

Outcome: ***Demonstrate the use oxy-fuel equipment for heating and cutting operations.***

1. Describe the safety precautions and devices for oxy-fuel equipment.
2. Describe oxygen and fuel gas cylinders, regulators and the nature of gases.
3. Describe set-up, pressure and flame adjustment, and shutdown, for oxy-fuel equipment.
4. Set-up oxy-fuel equipment.
5. Demonstrate heat treatment and cutting operations.

E. Layout Tools and Procedures ..... 3 Hours

Outcome: ***Demonstrate semi-precision and precision layout procedures.***

1. Describe the tools for layout procedures.
2. Describe the procedures for basic and precision layout.
3. Demonstrate layout procedures using layout tools.

F. Hand-Held Cutting Tools ..... 6 Hours

Outcome: ***Demonstrate the use of hand-held cutting tools common to the trade.***

1. Describe hacksaws and blades.
2. Describe parts, types, classification, shape and use of files.
3. Describe de-burring processes.
4. Describe taps and dies, stud and bolt removal tools, and the lubricant for these applications.
5. Describe hand reamers and hand broaching tools and their applications.
6. Describe the use of threaded inserts for thread repair operations.
7. Demonstrate the use of hand held cutting tools.

G. Measuring Tools ..... 4 Hours

Outcome: ***Measure workpieces using metric and imperial measuring tools.***

1. Describe basic measuring tools used in the machinist trade.
2. Describe precision measuring tools used in the machinist trade.
3. Describe the effects of temperature changes, with respect to measuring components.
4. Demonstrate the use and care of measuring tools.

H. Angular Measuring Tools ..... 3 Hours

Outcome: ***Demonstrate measuring workpieces using angular measuring tools.***

1. Describe the use of dial indicators, gauge blocks for measurement.
2. Describe the use of sine bars and of sine plates.
3. Describe the use of precision squares.

4. Describe the use of a bevel and plate and universal bevel protractors.
5. Demonstrate the use of angular measurement tools.

I. Screw Thread Terminology ..... 5 Hours

Outcome: Describe screw thread terminology.

1. Describe screw thread forms and their applications.
2. Describe the parts of external and internal screw threads.
3. Describe terminology associated with thread classification and fits.
4. Determine screw thread tolerances from charts and tables.

J. Screw Thread Measuring and Gauging ..... 3 Hours

Outcome: Demonstrate screw thread inspection methods.

1. Demonstrate screw thread calculations for 60° thread forms.
2. Demonstrate the methods used to accurately measure and gauge threads.

K. Inspection Gauges ..... 2 Hours

Outcome: Demonstrate the use of inspection gauges.

1. Describe types of inspection gauges.
2. Demonstrate the use of inspection gauges.

SECTION TWO: ..... MACHINE TOOLS ..... 140 HOURS

A. Hand Grinding Machines ..... 8 Hours

Outcome: Demonstrate the use of offhand grinding.

1. Describe the safety precautions when using offhand grinders.
2. Describe types of off-hand grinding machines.
3. Describe grinding wheels and their uses.
4. Describe the installation, trueing and dressing of grinding wheels.
5. Demonstrate maintenance and operation of offhand grinders.

B. Power Saws ..... 2 Hours

Outcome: Demonstrate the operation of power saws.

1. Describe the safety precautions when using power saws.
2. Describe the types, design features, and applications of power saws.
3. Describe the selection of saw blades and cut-off wheels.
4. Demonstrate the use of power saws.

C. Speeds, Feeds and Cutting Tools ..... 8 Hours

Outcome: Describe the cutting conditions for turning operations.

1. Describe the composition and characteristics of cutting tool materials.
2. Describe shapes, angles and clearances used when grinding a cutting tool.

3. Calculate turning speeds and feeds for cutting tool and workpiece materials.
4. Describe how variables such as machinability, rigidity and depth of cut affect speeds and feeds.
5. Select carbide insert shapes for turning applications.
6. Demonstrate the angles and clearances used when grinding a cutting tool.
7. Demonstrate the application of feed, speed, and depth of cut for turning operations.
8. Demonstrate the cutting conditions for threading.

D. Drilling Machines ..... 16 Hours

Outcome: ***Demonstrate the use of drilling machines.***

1. Describe the safety precautions when using drilling machines.
2. Describe the types, parts attachments and operation of drilling machines.
3. Describe tool and work holding devices.
4. Describe parts of a twist drill and the types of twist drill materials.
5. Describe special types of drills and reamers.
6. Describe metric, fractional, letter and number drill sizes and methods of measuring drill sizes.
7. Demonstrate the procedures for grinding a drill bit.
8. Demonstrate the techniques used to correct drilling issues.
9. Calculate the correct speeds and feeds for drill press operations.
10. Demonstrate drilling operations using drilling machines and attachments.

E. Lathes ..... 6 Hours

Outcome: ***Describe the sizing, parts, accessories and attachments of lathes.***

1. Describe the safety precautions when using lathes.
2. Describe the types, size and rated capacity of lathes.
3. Describe major parts of a lathe and their functions.
4. Describe work holding devices used on the lathe.
5. Describe tool posts and cutting tool holders.

F. Lathe Attachments and Accessories ..... 10 Hours

Outcome: ***Demonstrate the use of lathe attachments and accessories during lathe operations.***

1. Describe the set-up and application of attachments and accessories used on the lathes.
2. Describe the use of steady rests, follower rests, mandrels and turning between centers.
3. Demonstrate the use of attachments and accessories for lathes.

G. Lathe Operations ..... 58 Hours

Outcome: ***Demonstrate lathe set-up and operation.***

1. Set-up the cutting tool to perform parallel turning and boring operations.
2. Operate a lathe to turn to a shoulder.
3. Demonstrate center drilling, drilling and reaming operations.
4. Demonstrate the set-up and cutting of a taper on a lathe.

5. Demonstrate knurling, grooving, parting-off, forming and profiling, on a lathe.
6. Demonstrate the use of taps, dies, and single point tools to cut a thread.
7. Demonstrate set-ups for different operations on a lathe.

H. Machine Lubrication and Cutting Fluids ..... 2 Hours

Outcome: ***Demonstrate the application of lubricants.***

1. Describe the health hazards associated with cutting fluids.
2. Describe the characteristics and functions of cutting fluids.
3. Describe methods used to apply cutting fluids.
4. Describe lubrication schedules from manufacturer's specifications.

I. Introduction and Application of Computer Numerical Control (CNC) Turning Machines ..... 2 Hours

Outcome: ***Describe basic concepts and applications of CNC machines.***

1. Describe safety practices when using CNC machines.
2. Describe basic operational codes used in CNC programming and machining.
3. Describe basic types and applications for horizontal and vertical CNC turning centers.
4. Describe the advantages and disadvantages of CNC machines.

J. Machine Coordinate Systems for CNC Turning Machines ..... 2 Hours

Outcome: ***Describe the purpose of co-ordinate and reference points used for CNC lathe programs.***

1. Describe coordinate points of a workpiece using absolute and incremental values.
2. Describe the CNC lathe axis system.
3. Describe the purpose for reference points used on CNC turning centers.

K. Parts and Workholding Accessories for CNC Turning Machines ..... 2 Hours

Outcome: ***Describe the basic parts and workholding accessories for CNC turning centers.***

1. Describe the parts, functions and features of CNC turning centers.
2. Describe chucks and collets used on CNC turning centers.
3. Describe the safety practices when using CNC workholding accessories.
4. Demonstrate use of chucks and collets on CNC turning centers.

L. Set-up and Operation for CNC Turning Machines ..... 24 Hours

Outcome: ***Demonstrate the set-up and operation for turning centers.***

1. Describe the purpose of the major components and features of a typical CNC operator panel.
2. Describe methods of inputting, sorting and verifying CNC programs.
3. Describe the process and procedure for tooling set-up.
4. Describe the purpose and use of tool offsets.
5. Demonstrate tool set-up.
6. Demonstrate tool offset procedures.

7. Demonstrate overriding cutting conditions on turning centers.
8. Execute a CNC turning program.

SECTION THREE: ..... TRADE MATH ..... 32 HOURS

A. Working with Numbers .....4 Hours

Outcome: Perform mathematical operations with whole numbers.

1. Read whole numbers by using place values and perform rounding operations.
2. Perform addition and subtractions with whole numbers.
3. Perform multiplication and divisions with whole numbers.
4. Identify and perform operations with signed numbers.

B. Fractions and Decimals and Percentages .....4 Hours

Outcome: Solve problems involving fractions and decimals.

1. Identify key terms and concepts used when working with fractions.
2. Convert fractions mixed numbers and vice versa.
3. Identify common denominators.
4. Perform basic mathematical operations using fractions.
5. Solve problems using decimal numbers, fractions and mixed numbers.
6. Round whole numbers and decimals to specified place values.
7. Describe the relationship between decimal numbers, fractions and percentages.
8. Convert decimal numbers, fractions and percentages.

C. Algebra .....6 Hours

Outcome: Perform mathematical operations using algebra.

1. Describe algebraic functions.
2. Demonstrate the order of algebraic operations.
3. Demonstrate the ability to manipulate equations.
4. Solve problems using algebraic formulas.

D. Measurement and Conversions .....4 Hours

Outcome: Solve problems involving measurement and conversion.

1. Describe the basic units for length, mass, area, volume and temperature in both the imperial and metric (SI) systems.
2. Solve problems using the basic units from both imperial and metric systems.
3. Convert from imperial to metric and metric to imperial measurements.

E. Ratio and Proportion .....3 Hours

Outcome: Solve problems using ratio and proportion.

1. Describe two quantities in the form of a ratio.
2. Describe two ratios in the form of a proportion.

3. Solve problems using ratio and proportion.

F. Taper Systems.....3 Hours

Outcome: Apply taper systems to machining operations.

1. State four applications of tapers.
2. Identify the individual parts of a taper.
3. Describe methods used to measure or gauge an external or internal taper for fit and accuracy.
4. Identify eight taper systems and their applications.
5. Perform calculations for both metric and imperial tapers.

G. Introduction to Triangles and Trigonometry .....8 Hours

Outcome: Solve problems involving triangles and elementary trigonometry.

1. Describe the terms and concepts used in working with triangles.
2. Describe special triangles and solve problems using related formulas.
3. Describe Pythagorean Theorem and solve problems.
4. Describe the terms and concepts associated with trigonometry.
5. Use trigonometric formulae to determine missing triangular data.

SECTION FOUR: .....PRINT READING..... 32 HOURS

A. Introduction to Print Reading .....8 Hours

Outcome: Sketch basic components.

1. Describe the planes of an orthographic projection.
2. Describe first and third angle projections, and recognize the ISO symbol for each projection.
3. Describe the types of lines used on prints and their applications.
4. Apply basic rules to dimensions on a component drawing.
5. Sketch and dimension simple objects in orthographic projection.

B. Dimensioning Methods.....2 Hours

Outcome: Describe methods of dimensioning on a print.

1. Describe the methods of applying dimensions to a print.
2. Describe methods used to express the amount of taper on a component drawing.
3. Interpret dimensions on prints in either metric and imperial systems or dual dimensioning.
4. Calculate unspecified dimensions on a drawing.

C. Sections .....2 Hours

Outcome: Describe the technical elements of break lines and sectional representation.

1. Describe cutting plane lines, break lines and symmetry and their application.
2. Describe the use of sectional views and their applications.

D. Isometric Drawings ..... 2 Hours

Outcome: ***Sketch pictorial drawings.***

1. Describe types of pictorial views.
2. Interpret isometric drawings.

E. Surface Texture (Finish) - Turning ..... 3 Hours

Outcome: ***Describe concepts related to surface texture.***

1. Describe terms related to the production and measurement of surface textures.
2. Describe surface texture symbols used to indicate surface finish values.
3. Demonstrate machining or finishing process to produce a given surface texture.

F. Introduction to Geometric Dimensioning and Tolerancing ..... 3 Hours

Outcome: ***Interpret geometric dimensioning and tolerancing.***

1. Describe the terminology and purpose used in geometric dimensioning and tolerancing.
2. Describe basic symbols used in geometric dimensioning and tolerancing.
3. Verify geometric dimensioning and tolerancing on parts.

G. Introduction to Limits and Fits ..... 2 Hours

Outcome: ***Describe limits and fits used in machining.***

1. Describe the terminology and purpose of limits and fits.
2. Interpret limits and fits on prints.
3. Calculate allowances on mating parts.

H. Introduction to Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) ..... 8 Hours

Outcome: ***Describe the basics of CAD and CAM for turning.***

1. Describe the terminology and processes associated with CAD and CAM.
2. Generate geometry for basic turning processes.
3. Apply and verify tool paths for basic turning geometry.
4. Post process the tool path for a basic turning program.

I. Fasteners and Locking Devices ..... 2 Hours

Outcome: ***Describe the uses for threaded and non-threaded fasteners.***

1. Describe threaded fasteners and their applications.
2. Describe non-threaded fasteners and their applications.

SECOND PERIOD TECHNICAL TRAINING
MACHINIST TRADE
COURSE OUTLINE

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It is industry's intent that the practical portion of the program enhances the theory section of the course outline, Geometric Dimensioning and Tolerancing to be incorporated practically into all working drawings and that the Machinery Handbook be used in all periods of training. Due to the nature of the work of the Machinist trade it is imperative that safety, WHMIS and environmental concerns be taught on a continuous basis throughout the entirety of this course.

SECTION ONE: ..... METALLURGY AND HEAT TREATMENT ..... 18 HOURS

A. Ferrous Metals ..... 6 Hours

Outcome: ***Select the type of ferrous metals for an application.***

1. Describe the physical and mechanical properties of ferrous metals.
2. Describe alloying as a factor that changes physical and mechanical properties.
3. Describe heat-treating processes and the terminology associated with them.
4. Describe the characteristics of ferrous metals for machining operations.
5. Demonstrate the use of the classification system to identify metals.

B. Non-Ferrous Metal ..... 6 Hours

Outcome: ***Select the type of non-ferrous metals for an application.***

1. Describe the physical and mechanical properties of non-ferrous metals.
2. Describe the applications and mechanical properties of alloys.
3. Describe the characteristics of non-ferrous metals and alloys for machining operations.
4. Demonstrate the use of the classification system to identify metals.

C. Metal Specifications and Testing ..... 6 Hours

Outcome: ***Describe metal specifications and testing.***

1. Interpret charts and tables to select a metal for an application.
2. Describe methods of destructive testing of metals.
3. Describe methods of non-destructive testing of metals.
4. Describe aspects of material test reports (MTR).

SECTION TWO: ..... TOOLING ..... 16 HOURS

A. Tool and Work Holding Devices ..... 2 Hours

Outcome: ***Select the proper tool and work holding device for a milling operation.***

1. Describe tool holding devices and their applications for the milling machine.
2. Describe work holding devices and their applications for the milling machine.

B. Milling Cutters ..... 4 Hours

Outcome: ***Select a cutter for a milling application.***

1. Describe the types of materials used in the construction of milling cutters, their applications and limitations.
2. Describe the types of cutters used for horizontal milling operations.
3. Describe the types of cutters used for vertical milling machine operations.
4. Describe the care and handling of milling cutters.

C. Cutting Tool Materials ..... 4 Hours

Outcome: ***Describe chip formation, characteristics of cutting tool materials, methods of manufacture and applications.***

1. Describe the mechanics of chip formation.
2. Describe cutting tool materials and their manufacture.
3. Describe the application of different cutting tool materials.

D. Inserts and Tool Holders ..... 6 Hours

Outcome: ***Describe inserts and tool holders.***

1. Describe cutting tool geometry and its purpose.
2. Select carbide inserts and tool holders from charts.
3. Describe carbide tool failure and troubleshooting.
4. Demonstrate the replacement of inserts and tool holder hardware.

SECTION THREE: ..... MACHINE TOOLS ..... 154 HOURS

A. Milling Machines ..... 4 Hours

Outcome: ***Describe the types, size, parts, accessories and attachments of milling machines.***

1. Describe the safety precautions when using milling machines.
2. Describe type, size, and rated capacity of milling machines.
3. Describe the parts of milling machines and their functions.
4. Describe milling accessories and their applications.

B. Milling Operations ..... 58 Hours

Outcome: ***Demonstrate the set-up and operation of a milling machine.***

1. Describe conventional and climb milling.
2. Describe plain milling and face milling.
3. Describe the set-up for cutting slots and keyseats.
4. Describe the set-up for using a slitting saw.
5. Describe the set-up for drilling and boring on a milling machine.
6. Describe the set-up for straddle, gang and form milling.
7. Describe the set-up for milling T-slots and dovetails.

8. Demonstrate the set-up of tool holding devices for milling machines.
9. Demonstrate the set-up and operations on milling machines.
10. Calculate the cutting speed, feed and depth of cut for cutting tool and workpiece materials.
11. Select an insert for milling applications.

C. Dividing Head and Indexing ..... 6 Hours

Outcome: ***Describe methods of indexing using a dividing head.***

1. Describe the applications of a dividing head, and each individual part.
2. Describe direct, simple and angular methods of indexing.
3. Describe the use of a rotary table.

D. Threading ..... 20 Hours

Outcome: ***Describe the types and uses of multiple start threads, translational threads, and taper threads.***

1. Describe the purpose of multiple start threads.
2. Describe the types and uses of translational threads.
3. Describe types and uses of rotary shoulder and taper threads.
4. Demonstrate cutting screw thread forms with single point tools.

E. Program and Machine Co-ordinate Systems for CNC Machining Centers ..... 2 Hours

Outcome: ***Describe the purpose of co-ordinate and reference points used for CNC milling programs.***

1. Describe co-ordinate points of a workpiece using absolute and incremental values.
2. Describe the purpose of the CNC machining center axis system.
3. Describe the purpose for reference points used on CNC machining centers.

F. Parts for CNC Machining Centers ..... 4 Hours

Outcome: ***Describe basic parts for CNC machining centers.***

1. Describe the parts, functions and features of CNC machining centers.
2. Describe workholding devices for CNC machining centers.
3. Describe safety practices when using CNC workholding accessories.

G. Programming Concepts and Codes for CNC Machining Centers ..... 6 Hours

Outcome: ***Describe programming concepts and codes.***

1. Describe elements of a CNC milling program.
2. Describe the purpose of preparatory (G) and miscellaneous (M) codes.
3. Describe tool, feed rate, speed and related program commands.
4. Describe tool and workpiece co-ordinates, and related program codes.
5. Create a basic CNC milling program.

H. Set-up and Operation for CNC Machining Centers ..... 50 Hours

Outcome: Demonstrate the set-up and operation for machining centers.

1. Describe the features on the operator's panel of a machining center.
2. Describe the process and procedure for tooling set-up.
3. Describe the purpose and use of tool offsets.
4. Describe cutting conditions on machining centers.
5. Demonstrate tool offset procedures.
6. Demonstrate tool set-up.
7. Demonstrate the execution of a CNC machining program.

I. Process Planning ..... 4 Hours

Outcome: Describe the reasonable sequence of events necessary to complete a job.

1. Describe the planning process to complete a job.
2. Develop a plan to complete a job.

SECTION FOUR: ..... TRADE MATHEMATICS ..... 24 HOURS

A. Applied Mathematics ..... 14 Hours

Outcome: Apply mathematics using calculations, tables and charts.

1. Perform calculations on practical applications involving triangle theory and methods.
2. Perform calculations on practical applications involving ratio and proportion formula.
3. Using the Machinery's Handbook read and interpret tables, charts and graphs.
4. Calculate simple mechanical forces.

B. Applied Geometry ..... 10 Hours

Outcome: Apply geometry in calculation and problem solving.

1. Describe terminology and shapes associated with common geometric forms.
2. Describe formulae to determine the size of common geometric forms.
3. Apply trigonometric formulas to solve problems.
4. Determine circle feature values through calculation.
5. Calculate thread geometry.

SECTION FIVE: ..... PRINT READING ..... 28 HOURS

A. Interpret and Sketch Prints ..... 8 Hours

Outcome: Interpret and sketch prints containing advanced technical information.

1. Identify accumulation of tolerances.
2. Apply dimensions to tapers on sketching exercises.
3. Sketch and dimension technical element such as threads, boxes and countersinks.
4. Sketch and interpret a component in orthographic projection having an auxiliary view.
5. Sketch a pictorial drawing showing inclined surfaces, tapers and other technical elements.

B. Advanced Geometric Dimensioning and Tolerancing ..... 4 Hours

Outcome: ***Interpret geometric dimensioning and tolerancing (GD&T).***

1. Describe terminology and symbols used in geometric dimensioning and tolerancing.
2. Verify geometric dimensioning and tolerancing on parts.

C. Surface Texture (Finish) – Milling ..... 2 Hours

Outcome: ***Describe concepts related to surface texture.***

1. Describe how different machining processes affect the lay.
2. Demonstrate how to measure a surface texture on a workpiece.
3. Demonstrate machining or finishing process to produce a given surface texture.

D. Application of Limits and Fits ..... 4 Hours

Outcome: ***Describe interchangeability between machined parts through the application of standards of limits and fits.***

1. Describe the terminology related to standards of limits and fits.
2. Describe the application of standards of limits and fits to machined parts.

E. Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) ..... 8 Hours

Outcome: ***Describe the basics of CAD and CAM for milling.***

1. Describe the terminology and processes associated with CAD and CAM.
2. Create geometry for a basic milling process.
3. Apply and verify tool paths for basic milling geometry.
4. Post process the tool path for a basic milling program.

F. Assembly and Sub-Assembly Drawings ..... 2 Hours

Outcome: ***Define the purpose of assembly drawings.***

1. Interpret part identification methods and bill of material on assembly drawings.
2. Interpret information found on assembly drawings and sub-assembly drawings.

THIRD PERIOD TECHNICAL TRAINING
MACHINIST TRADE
COURSE OUTLINE

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SECTION ONE:..... COMPUTER NUMERICAL CONTROL MACHINES (CNC)..... 94 HOURS

A. Codes and Formats .....6 Hours

Outcome: ***Describe CNC concepts, programming codes and applications for turning centers.***

1. Describe CNC concepts and terminology.
2. Describe the components of typical program formats.
3. Describe the block-skip function.
4. Set up and operate a CNC turning center using G, M, S, T and F codes.

B. Linear and Circular Interpolation .....4 Hours

Outcome: ***Program and apply linear and circular tool path motions for workpieces.***

1. Describe the programming elements of linear tool path motions (linear interpolation) for turning operations.
2. Describe the programming elements of circular interpolation for turning operations.
3. Demonstrate the use of arc modifiers for circular interpolation.
4. Create a CNC lathe program including linear and circular tool path motions.

C. Canned Cycles .....4 Hours

Outcome: ***Create a CNC program using canned cycles for facing, turning and boring operations.***

1. Describe the application of canned cycles for turning, facing and boring.
2. Demonstrate the use of canned cycles for square and tapered facing operations.
3. Demonstrate the use of canned cycles for cylindrical and tapered turning operations.
4. Demonstrate the use of canned cycles for cylindrical and tapered boring operations.

D. Multiple Repetitive Cycles .....8 Hours

Outcome: ***Demonstrate repetitive machining cycles for turning, boring, facing, radial and face grooving, and drilling operations.***

1. Describe the application of multiple repetitive machining cycles.
2. Demonstrate the use of turning and boring repetitive cycles.
3. Demonstrate the use of facing repetitive cycles.
4. Demonstrate the use of pattern repeating repetitive cycles for pre-shaped forgings and castings.

5. Demonstrate the use of repetitive cycles for radial grooving operations.
6. Demonstrate the use of repetitive cycles for face grooving operations.
7. Demonstrate the use of repetitive cycles for drilling operations.

E. Tool Nose Radius Compensation (TNRC) ..... 3 Hours

Outcome: ***Demonstrate the use of TNRC for CNC turning operations.***

1. Describe the purpose of TNRC for turning operations.
2. Describe vector direction for TNRC.
3. Demonstrate G40, G41 and G42 codes used in TNRC for turning operations.

F. CNC Threading ..... 5 Hours

Outcome: ***Perform the calculations required for programming threading cycles.***

1. Describe the terminology associated with threading cycles.
2. Describe tool infeed and retraction methods for threading.
3. Describe applications for acceleration, deceleration and offset distances.
4. Describe the cutting conditions for threading.
5. Determine the infeed, accumulative infeed and starting positions for RH and LH threading.

G. Programming CNC Threads ..... 6 Hours

Outcome: ***Develop CNC threading programs.***

1. Select inserts and tooling for threading operations.
2. Demonstrate canned and repetitive cycles for cylindrical threading operations.
3. Demonstrate threading cycles for tapered threading operations.
4. Demonstrate programming for multiple start threads.
5. Demonstrate programming for tapping operations.
6. Identify common threading problems, causes and solutions.

H. Tool Measurements ..... 4 Hours

Outcome: ***Describe terms, concepts and tool measuring methods used on CNC turning centers.***

1. Describe the terms and concepts used in tool measurement and offsets.
2. Demonstrate the programming application of vector direction and radius values.
3. Demonstrate tool measurement using a master reference tool and workshift.
4. Demonstrate automatic tool measurements using a qualified tool setter and workshift.

I. Machine Operations ..... 48 Hours

Outcome: ***Demonstrate control features and functions for machine set-up and operations.***

1. Describe the control features and functions for turning operations.
2. Demonstrate program input, storage, editing and verification.
3. Demonstrate tool set-up on a CNC turning center.
4. Set up and execute a program on a CNC turning center.

J. Multi Axis Turning ..... **6 Hours**

Outcome: ***Demonstrate live tooling set-up and operations.***

1. Describe the purpose and use of C and Y axis.
2. Describe the purpose and use of multi spindle turning center.
3. Describe the purpose and use of multi turret turning centers.
4. Demonstrate the set-up and operation of live tooling.

SECTION TWO: ..... **MACHINE TOOLS** ..... **90 HOURS**

A. Gearing ..... **5 Hours**

Outcome: ***Describe basic gear operation and applications.***

1. Describe types of gears and their applications.
2. Describe the purpose of the five standard gear tooth pressure angles.
3. Calculate the speed and gear ratios for simple and compound gears.

B. Spur Gears ..... **6 Hours**

Outcome: ***Describe indexing and spur gears.***

1. Describe the terminology associated with each part of a spur gear.
2. Spur gear calculations.
3. Demonstrate set-up and cutting of a spur gear.

C. Bevel Gears ..... **4 Hours**

Outcome: ***Describe the elements and applications of bevel gears.***

1. Describe the types and applications of bevel gears.
2. Describe the main elements of bevel gears.

D. Helical Gears ..... **4 Hours**

Outcome: ***Describe the elements and applications of helical gears.***

1. Identify the main elements of helical gears.
2. Identify applications for helical gears, as well as their advantages and disadvantages.

E. Gear Manufacturing Methods ..... **12 Hours**

Outcome: ***Describe the process of manufacturing precision gear systems.***

1. Calculate the required dimensions when cutting a spur gear and rack.
2. Describe methods of manufacturing and finishing gears.
3. Describe the inspection methods used to measure the design specifications on gears.
4. Demonstrate the set-up for hobbing a gear on a milling machine.

F. Multi Start and Worm Threading ..... **12 Hours**

Outcome: ***Perform calculations and operations for multi start and worm threading.***

1. Describe the basic elements of plain, single enveloping, and double enveloping worm threads.

2. Describe the methods and materials used in the manufacture of worm threads.
3. Calculate the size of the basic elements.
4. Describe the characteristics and applications of multiple start threads.
5. Demonstrate the set-up and perform multi start thread cutting on the lathe.

G. Abrasives ..... 6 Hours

Outcome: Describe abrasives and their uses.

1. Describe types and uses of abrasives.
2. Describe grinding wheel nomenclature and types.
3. Select a grinding wheel for specific applications.

H. Grinding Machines ..... 24 Hours

Outcome: Demonstrate grinding machines and processes.

1. Describe the types, parts, holding devices and operation of surface and cylindrical grinders.
2. Describe the purpose of truing and dressing grinding wheels.
3. Demonstrate the mounting and truing of grinding wheels.
4. Demonstrate balancing and dressing operations on grinding wheels.
5. Demonstrate grinding operations on grinders.

I. Machine Broaching ..... 2 Hours

Outcome: Demonstrate broaches and broaching machines.

1. Describe the design and application of broaches.
2. Set-up and perform broaching operations.

J. Splines ..... 10 Hours

Outcome: Describe methods for producing splines.

1. Describe the types of splines and their applications.
2. Describe the methods and fits of manufacturing splines.
3. Demonstrate manufacturing of straight sided splines.

K. Fixtures ..... 5 Hours

Outcome: Describe the design and application of fixtures.

1. Describe the design principles and applications of fixtures.
2. Describe locating and clamping devices of fixtures.
3. Demonstrate the use and application of fixtures.

SECTION THREE: ..... TRADE MATHEMATICS ..... 24 HOURS

A. Applied Mathematics ..... 2 Hours

Outcome: Perform calculations.

1. Solve problems by interpreting and using data from tables, charts and graphs found in the Machinery's Handbook.

B. Trigonometry Applications ..... 10 Hours

Outcome: Perform calculations using trigonometry.

1. Solve problems for parts of different triangles.
2. Use trigonometry to solve machining problems.

C. Advanced Limits and Fits ..... 12 Hours

Outcome: Design a GO/NO GO inspection gauge.

1. Calculate fits and dimensions for designing gauges.
2. Describe implications of surface finishes and GD&T.
3. Design a GO/NO GO inspection gauge.

SECTION FOUR: COMPUTER AIDED DESIGN AND COMPUTER AIDED MANUFACTURING ..... 32 HOURS

A. Computer Aided Design (CAD) ..... 14 Hours

Outcome: Demonstrate a CAD drawing for turning.

1. Create the geometry for grooving, threading and profiling applications.
2. Edit imported CAD drawings.

B. Computer Aided Manufacturing (CAM) ..... 14 Hours

Outcome: Demonstrate tool path generation for turning, including live tooling.

1. Apply and verify tool paths for advanced turning processes.
2. Create a tool library.
3. Demonstrate use of live tooling / C-axis for CAM processes.

C. Co-ordinate Measuring Machine Technology (CMM) ..... 2 Hours

Outcome: Describe Co-ordinate Measuring Machine Technology (CMM)

1. Describe Co-ordinate Measuring Machine Technology.
2. Describe the function, parts and use of CMM's.
3. Demonstrate how a CMM is used to accurately measure components.

D. Advanced Process Planning – Estimating ..... 2 Hours

Outcome: Use a machine shop estimating process.

1. Describe the terms and concepts related to estimating.
2. Determine the cost of materials for a job.
3. Determine the cost of labour for a job.
4. Perform a final cost estimate for a job.

FOURTH PERIOD TECHNICAL TRAINING
MACHINIST TRADE
COURSE OUTLINE

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SECTION ONE:..... COMPUTER NUMERICAL CONTROL MACHINING CENTERS ..... 126 HOURS

A. Codes and Formats ..... 8 Hours

Outcome: ***Describe CNC concepts, programming codes and applications for machining centers.***

1. Describe CNC concepts and terminology.
2. Describe the components of typical program formats.
3. Set up and operate a CNC machining center using G, M, S, T and F codes.
4. Demonstrate the use of workshift and tool length offset program codes.

B. Advanced Linear and Circular Interpolation ..... 6 Hours

Outcome: ***Demonstrate linear and circular interpolation for profile milling operations.***

1. Describe the elements of linear tool path motions (linear interpolation) for milling operations.
2. Describe elements of circular interpolation for milling operations.
3. Write a CNC program including linear and circular tool path motions for machining centers.
4. Demonstrate the use of arc modifiers for circulation interpolation.

C. Canned Cycles ..... 6 Hours

Outcome: ***Demonstrate canned cycles used for drilling, boring and tapping operations performed on CNC machining centers.***

1. Describe program variables used in canned cycles.
2. Describe the use of drilling, tapping and boring canned cycles.

D. Program Applications for Canned Cycles ..... 14 Hours

Outcome: ***Demonstrate canned cycle programs for hole making operations for CNC machining centers.***

1. Calculate co-ordinate points for typical hole patterns.
2. Calculate depth of holes for drilling operations.
3. Demonstrate canned cycles for drilling type operations including tapping and boring.
4. Demonstrate canned cycles with repeat (L) function for linear and grid hole patterns.
5. Demonstrate canned cycles using polar co-ordinates.

E. Cutter Compensation ..... 4 Hours

Outcome: ***Demonstrate cutter compensation for machining workpiece profiles on CNC machining centers.***

1. Describe the purpose of cutter compensation for milling operations.
2. Describe program codes, machine settings and guidelines for cutter compensation.
3. Demonstrate G40, G41 and G42 codes used in cutter compensation for milling operations.

F. Programming Concepts and Applications ..... 20 Hours

Outcome: ***Describe advanced programming concepts and applications.***

1. Describe concepts for macro programing.
2. Describe mirror image for machining applications.
3. Describe co-ordinate rotation for machining applications.
4. Demonstrate workpiece coordinate system shift programming techniques.
5. Demonstrate the use of subprograms for appropriate machining applications.
6. Demonstrate helical milling for hole making and thread milling operations.

G. Set-Up and Operations ..... 50 Hours

Outcome: ***Demonstrate machining operations on CNC machining centers.***

1. Demonstrate loading of tools, input tool numbers and tool geometry.
2. Demonstrate the sequence of operations for tool changers.
3. Demonstrate tool length and tool length offset measurements.
4. Demonstrate workpiece co-ordinate or workshift measurements.
5. Execute a program on a computer numerically controlled machining center.

H. Multi Axis Milling ..... 18 Hours

Outcome: ***Set-up and operate a fourth axis.***

1. Describe fourth axis machining.
2. Describe multi axis machining.
3. Set up and operate fourth axis milling.

SECTION TWO: ..... MACHINE TOOLS ..... 58 HOURS

A. Boring Mills ..... 16 Hours

Outcome: ***Demonstrate operations performed on boring mills.***

1. Describe safety, types, parts, and controls of horizontal and vertical boring mills.
2. Describe accessories, operations, speeds and feeds of boring mills.
3. Demonstrate set-up and perform boring operations on a boring mill.

B. Bearings and Seals ..... 10 Hours

Outcome: ***Describe the selection and installation of bearings and seals.***

1. Describe the types and applications of plain bearings.

2. Describe the types and applications of roller bearings.
3. Describe bearing installation and fits.
4. Describe types and applications of seals.
5. Demonstrate machining of bearing journals.

C. Advanced Machining ..... 20 Hours

Outcome: ***Demonstrate critical set-up of rotating components.***

1. Apply geometric dimensioning and tolerancing on machining applications.
2. Use work holding devices in machining operations.
3. Demonstrate repair procedures for parts and components.
4. Apply geometric dimensioning and tolerancing on parts and components for a gearbox.
5. Demonstrate procedures for critical alignment of components.

D. Specialized Manufacturing ..... 12 Hours

Outcome: ***Describe non-traditional process used in manufacturing.***

1. Describe the processes and applications of electrochemical machining to remove metal.
2. Describe the use of thermal processes for machining metal.
3. Describe the process and applications of powder metallurgy for the mass production of parts.
4. Describe methods of deep-hole drilling and their applications.
5. Discuss new technological advancements that are relevant to manufacturing processes.
6. Describe safety practices when using Electrical Discharge Machining (EDM).
7. Describe the function, parts and accessories of EDM's.
8. Describe portable machining.

SECTION THREE: ..... COMPUTER AIDED DESIGN AND MANUFACTURING ..... 32 HOURS

A. Computer Aided Design (CAD) ..... 16 Hours

Outcome: ***Demonstrate CAD drawing for milling.***

1. Create the geometry for advanced machining processes.
2. Edit imported CAD drawings.

B. Computer Aided Manufacturing (CAM) ..... 16 Hours

Outcome: ***Demonstrate tool path generation for milling.***

1. Apply and verify the tool path for advanced milling processes.
2. Demonstrate the use of 4th axis in CAM processes.

SECTION FOUR: ..... METROLOGY, COACHING AND GOVERNANCE ..... 24 HOURS

A. Measuring, Gauges and Comparators ..... 5 Hours

Outcome: ***Describe inspection gauges and comparators for indirect measurement.***

1. Describe inspection gauges and comparators.

2. Describe methods of comparison measurement.
3. Demonstrate how to use precision measuring systems to measure flatness and surface finish.

B. Calibration of Measuring Tools ..... 4 Hours

Outcome: ***Describe methods of checking and calibrating precision measuring tools.***

1. Describe a system for determining the accuracy of micrometers and dial indicators using gauge blocks.
2. Describe methods of determining whether a gauge is within tolerances.

C. Co-ordinate Measuring Machine (CMM) ..... 12 Hours

Outcome: ***Demonstrate Co-ordinate Measuring Machine Technology (CMM)***

1. Describe advanced functions of a CMM.
2. Demonstrate how a CMM is used to accurately measure milled components.

D. Workplace Coaching Skills ..... 1 Hour

Outcome: ***Display coaching skills.***

1. Describe the coaching skills used for training apprentices.

E. Alberta's Industry Network ..... 1 Hour

Outcome: ***Describe the role of the Alberta Apprenticeship and Industry Training Board and the network of industry committees that represent the trades and occupations in Alberta.***

1. Describe Alberta's apprenticeship and industry training system.
2. Describe the role and the purpose of the Alberta Apprenticeship and Industry Training Board, government and post-secondary institutions.
3. Describe the roles and responsibilities of the PACs, LACs and occupational committees.

F. Interprovincial Standards Red Seal Program ..... 1 Hour

Outcome: ***Use Red Seal products to challenge an Interprovincial examination.***

1. Identify Red Seal products used to develop Interprovincial examinations.
2. Use Red Seal products to prepare for an Interprovincial examination.

Apprenticeship and Industry Training

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